

Ethics in the provision of removable partial dentures

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Abstract

Aim: To investigate the construction of cobalt-chromium removable partial dentures by commercial private dental laboratories. **Methods:** Ninety master casts for fabrication of cobalt-chromium removable partial dentures were obtained from three commercial laboratories randomly selected. Casts were assessed for dental arch treated, Kennedy classification, cast surveying, denture design information provided by the dentist, and mouth preparation (rest seat, guiding plane and retentive area). Dental technicians answered a questionnaire regarding qualification of assisted dentists, monthly number of framework castings, and use of dental surveyor. Mouth preparation was compared among laboratories using Kruskal-Wallis test ($\alpha=0.05$). **Results:** The percentage of Kennedy class I was 16%, class II 19%, class III 56%, and class IV 9%. The majority of master casts (51%) examined was sent to dental laboratories without any design information and did not comply with ethical guidelines in the provision of RPD. Approximately half of the casts were considered "inappropriate" for guiding planes and retentive areas. One of the laboratories presented all casts "inappropriate" for rest seat distribution ($p<0.001$). **Conclusions:** Mouth preparation frequently failed for guiding planes, retentive areas and distribution of rest seats. It is necessary to provide students with adequate clinical experience at the dental school environment, which will actually be carried into the practice of dentistry.

Keywords: dental technician, denture design, dentist's attitudes, mouth preparation.

Introduction

According to data from the last epidemiological assessment of Brazilians' oral health, accomplished by the Ministry of Health in 2010, sixty-nine percent of the Brazilian adult population needs some kind of dental prosthesis¹. It was also found that need for prosthetic treatment is markedly associated with socioeconomic factors. In the United States, prospective analysis has shown that the substantial growth in the U.S. population and extended life expectancy may contribute to increase the prevalence of partially dentate adults by the year 2020². The authors argue that adults are retaining more of their teeth throughout life and a larger proportion of partially edentulous patients will require removable and/or fixed partial dentures. Removable partial denture (RPD) is an appropriate treatment

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for partial edentulism, and may be suitable for a wide range of clinical situations³. Patients with one missing tooth as well as those with at least one remaining abutment may be rehabilitated with this treatment modality. Additionally, RPD offers a less expensive option of prosthetic treatment than implant assisted restorations and fixed partial dentures, and implicates lower biological cost (tooth preparation) if the patient cannot afford or is not sure about implant treatment at that moment.

The dentist is responsible for all phases of a RPD service in the strict sense of the word, although the dental laboratory technician is requested to perform certain technical phases of the service³. The creation of an optimal RPD design is dependent on the following factors: clinical knowledge and training; a thorough assessment of the patient; appropriate treatment planning including surveyed diagnostic casts and mouth preparation; and technical expertise and knowledge of laboratorial procedures and properties of materials. Clearly the dentist's contribution is related primarily to the first three aspects while the technician's contribution is concerned with the fourth⁴.

If inappropriately designed, planned, or placed, RPDs may have deleterious effects on oral health and supporting structures, as caries and periodontal disease⁵. Unfortunately, studies have reported that dentists are often negligent with fundamental principles for the construction of RPD and frequently fail to comply with ethical and legal requirements⁶⁻¹². Impressions and master casts for RPDs are frequently sent to dental laboratories without mouth preparation and written instructions of design information. This problem seems to be worldwide, as it has been reported in developing countries such as South Africa⁹ and Kingdom of Bahrain¹², as well as developed countries such as the United Kingdom⁶, Canada⁷, Sweden⁸, Ireland¹¹ and the United States¹⁰. However, no scientific data about RPD prescription in South America has been indexed on Medline/Pubmed. Therefore, the purpose of this study was to investigate the construction of RPD by commercial private dental laboratories in Natal, Brazil.

Material and methods

This cross-sectional survey was approved by the Research Ethics Committee of the Federal University of Rio Grande do Norte (protocol n° 095/09). Full name list and contact details of dental laboratory technicians regularly

registered and working in the city of Natal, Brazil were obtained from the Regional Dental Council. A telephone contact revealed that only 8 of the 87 commercial laboratories in the city of Natal had the facility to cast cobalt-chromium RPD frameworks. Three of them were randomly selected to join the study and denominated Lab I, II and III. The laboratories were visited and the laboratory technicians were asked to answer a questionnaire. Questionnaires were structured to collect data about the qualification of the dentists assisted by the laboratories, monthly number of framework castings, and use of dental surveyor. Anonymity and confidentiality of participants' personal information as well as of their responses to questions were assured.

Thirty master casts for fabrication of cobalt-chromium RPDs were obtained from each commercial laboratory, in a total of 90 casts. All master casts were photographed (FinePix A900; Fujifilm, Valhalla, USA) and evaluated by the same examiner. The photographic technique was standardized, enabling evaluation of the casts as well as the design of the dentures¹³. Data were collected regarding dental arch treated, Kennedy classification, cast surveying, and denture design information provided by the dentist. With the cast positioned on the dental surveyor, mouth preparation was assessed for retentive areas, guiding planes and rest seat distribution. Retentive areas were evaluated by the magnitude of the angle of cervical convergence below the point of convexity (horizontal retention), and the depth at which the clasp terminal is placed in the angle (vertical retention). Undercuts of 0.01 inch and clasp terminals placed at least 2 mm depth in the angle of convergence were considered satisfactory³. Guiding planes were evaluated by measurement of vertical and horizontal lengths. As a rule, proximal guiding plane surface should extend horizontally about one third of the buccal lingual width of the tooth, and vertically about two thirds of the length of the enamel crown portion from the marginal ridge cervically³. Rest seat distribution was evaluated according to the classical biomechanical principles for RPD design proposed in the available literature^{3,14-15}. According to the above mentioned criteria, retentive areas, guiding planes and rest seat distribution were classified as "completely appropriate", "partially appropriate" or "inappropriate" (Table 1). Classes were converted into scores and means were compared among laboratories using Kruskal-Wallis test ($\alpha=0.05$).

Table 1. Criteria for assessment of mouth preparation.

Classification	Rest seat distribution	Retentive areas	Guiding planes
Completely appropriate	Adjacent to edentulous areas in tooth-supported RPD, except when molar tooth is mesially inclined. Mesial rest for distal extension RPD. Auxiliary rests must provide indirect retention.	Vertical and horizontal retentions are satisfactory.	Vertical and horizontal extensions are satisfactory.
Partially appropriate	One or two rest seats are inadequate, but it does not disrupt the biomechanics.	Horizontal or vertical retention is satisfactory.	Horizontal or vertical extension is satisfactory.
Inappropriate	There is no rest seat preparation, or location of rest seats is completely inadequate.	Vertical and horizontal retentions are unsatisfactory.	Vertical and horizontal extensions are unsatisfactory.

Results

According to the answers to the questionnaires, Lab I and II have a monthly number of framework castings that ranges from 100 to 200, and serve private general practitioners as well as prosthodontists. Additionally, Lab II also assists dental schools and graduate programs/courses. Lab III assists primarily private general practitioners, and has a monthly number of framework castings that ranges from 50 to 100. Sixty percent of the master casts were from maxillary arches, while 40% were from mandibular arches. Kennedy Class III was the most common type of partially edentulous arch (56%). The percentage of Kennedy class I RPDs was 16%, class II 19%, and class IV 9%. Sixty-five percent of the casts exhibited at least one modification.

Fifty-one percent of the casts were sent to dental laboratories without any design information, and this function was delegated to the dental technician. The design was accomplished by dentists in 49% of the cases, and communicated to the dental technician by different manners: as the outline of the framework on the cast (35%), written instructions (2%), and just by rest seats (12%). All laboratories assured to use the dental surveyor. Assessment of guiding planes, retentive areas and rest seats are shown on Figures 1 and 2. Approximately half of the casts presented "inappropriate" for guiding planes and retentive areas. One of the laboratories presented all casts "inappropriate" for rest seats. Rest seat distribution was significantly different among laboratories ($p < 0.001$), while no significant difference was found for guiding planes and retentive areas.

Discussion

This study evaluated the construction of cobalt-chromium RPDs by three commercial private dental laboratories in the city of Natal, Brazil. A representative sample of commercial laboratories that have the facility to cast cobalt-chromium RPD frameworks was randomly selected (37.5%). Three laboratories were visited, dental technicians interviewed, and 90 master casts photographed and evaluated on dental surveyor. Therefore, it was possible to observe the practices of dentists by assessment of the master casts sent to dental laboratories, instead of asking them about their attitudes. This is important because it has been previously shown that dentists' practices are different from their knowledge¹⁶. Kennedy Class III was the most common type of partially edentulous arch (56%). It may result from the fact that adults are retaining more of their teeth throughout life.

For guiding planes, almost half of the casts were considered "inappropriate" (49%), and no cast was "completely appropriate". This trend has also been shown by Schwarz and Barsby¹⁷, who found that only 6% of the general dental practitioners frequently prepare guiding planes. Adequate guiding planes should be planned to establish the path of placement and dislodgement. Properly prepared guiding surfaces contribute to the retention and stability of the RPD, and may improve masticatory efficiency up to

40%.¹⁸ Although no statistically significant difference was found for guiding planes among dental laboratories ($p = 0.229$), the percentage of "partially appropriate" guiding planes was higher for Lab II (64%). A possible explanation is that Lab II works for dental schools and graduate programs/courses, which means that treatments are developed under the supervision of a Prosthodontics professor.

Lab II also presented the highest percentage for "completely appropriate" retentive areas (44%), and the reason may be the same mentioned above. Interestingly, although questionnaires have revealed that all dental laboratories assured to use the dental surveyor, no cast presenting evidence of surveying was found. This may explain why 53% percent of the casts were considered "inappropriate" for retentive areas. It is impossible to select a site on dental surface with adequate undercut gauge by visual examination. A dental surveyor must be used to locate the exact undercut that retentive clasp terminals will occupy and mark it on the master cast. Undercuts of 0.01 inch are adequate for retention by cobalt-chromium cast retainers³. Dentists using insufficient or too deep undercuts for clasps in their RPDs have experienced poorly fitting clasps to abutments, poorly fitting RPDs in patients' mouth, pain in the abutment and events of deformed, bent and broken clasps¹⁹.

Philosophies of RPD support are based on principles of broad or selective distribution of occlusal forces^{3,14-15}. Occlusal and incisal rests are important supporting elements that serve to transmit vertical forces to abutment teeth and to direct those forces along the long axes of teeth²⁰. In this study, 63% of the casts were "inappropriate" for rest seat distribution. Of these, 57% had no rest seat preparation. Recently, it was found that just 30% of the master casts with prescribed occlusal and cingulum rests had an obvious rest seat preparation. In many instances, rest seats were over-prepared or under-prepared, and the interocclusal clearance available for the planned rest was inappropriate²¹. Rest seats must provide adequate space for rest thickness, be strong enough to endure functional stress and prevent premature contact²⁰. Other common faults observed in this study were the placement of a distal rest in free-end RPDs (10%) and inadequate indirect retention (17%). As a general rule, while rest seats are commonly adjacent to edentulous areas in tooth supported RPDs, there are theoretical advantages for positioning a mesial occlusal rest in extension base RPDs: anterior position of the fulcrum line, reduction in need of indirect retention, and increased resistance to distal displacement of the denture^{3,14-15}.

Rest seat distribution was significantly different among laboratories ($p < 0.001$). Lab III presented 100% of the casts "inappropriate", while Lab I and II, 52% and 36%, respectively ($p < 0.001$). This difference may be explained by the qualification of dentists assisted by Lab III, which is primarily composed of general practitioners, in contrast to Lab I and II, which also assist prosthodontics specialists, dental schools and postgraduate courses. The tendency for an association between dentist's knowledge and denture

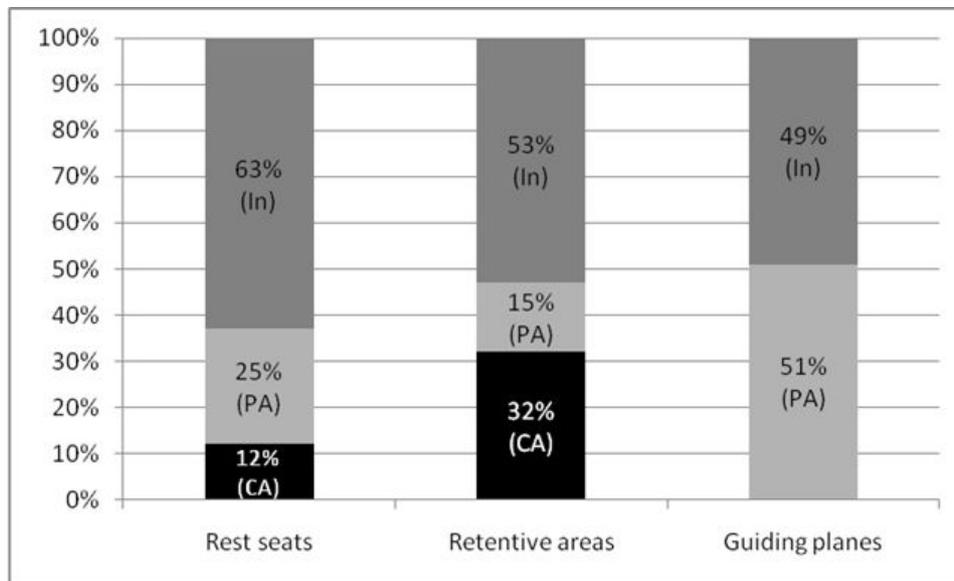


Fig. 1. General assessment of master casts for mouth preparation. Inappropriate (In), Partially Appropriate (PA), Completely Appropriate (CA).

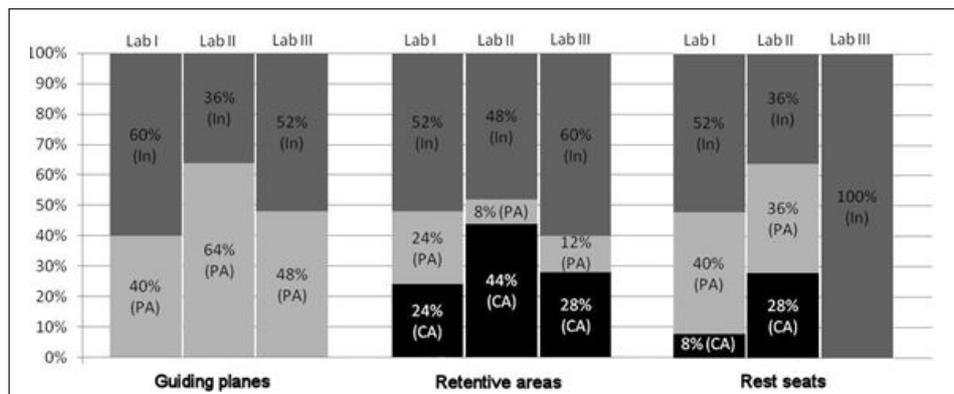


Fig. 2. Assessment of mouth preparation according to dental laboratories. Inappropriate (In), Partially Appropriate (PA), Completely Appropriate (CA).

service quality is also supported by the lowest percentage of “inappropriate” casts presented by Lab II for all items assessed. Various studies have shown that most general practitioners neglect fundamental RPD principles and transfer the responsibility for planning the prosthesis to dental laboratory technicians⁶⁻¹². The reason for this is not clear, but two hypotheses may explain this issue: dentists may disregard the acquired knowledge in order to save time and expedite the treatment; or dentists may receive inadequate orientation from dental schools during graduation²². A previous study found that educational factors seem to have a more significant effect on this issue than financial factors²³. Another study revealed that the majority of dentists are aware that success will be positively influenced if they design the RPD, but only half reported that they did this in their practice¹⁶. A recent study showed that only 12% of senior dental students from a representative number of dental schools in the State of São Paulo, Brazil, were capable of accomplishing completely appropriate mouth preparations and RPD designs²². The authors suggested that immediate

changes in the teaching of RPD are necessary with emphasis on the treatment planning, mouth preparation and survey and design principles.

Inappropriately designed RPDs may have potentially harmful effects, such as gingival irritation, tooth mobility, root caries, tooth loss, and low patient satisfaction⁵. Previous studies have shown that the number of cobalt-chromium RPDs constructed by dental laboratories without any written communication of the design may be higher than 90%⁶⁻¹². In the present study, 51% of the casts were sent to dental laboratories without any design information. When the design was communicated to the dental technician, it was done in different manners, as the outline of the framework on the cast (35%), written instructions (2%), and only by rest seats (12%). It is suggested that a satisfactory work authorization for a RPD design takes the form of an annotated diagram of the design accompanied with written instructions. Alternatively, a photocopy of the working cast may be taken and the design drawn on it. The design of the RPD framework also should be drawn on the study cast to transmit this



Fig. 3. RPD framework drawn on the study cast to transmit this information to the prosthodontic technician.

information to the technician, since subsequent transfer of two-dimensional information by the technician from the paper diagram to the three-dimensional cast can lead to errors of interpretation (Figure 3)⁴. Clarification of the design diagram may be achieved by using a color code to identify different RPD components or functions.

Although all investigated dental laboratories affirmed to use a dental surveyor, no evidence of cast surveying was found. Surveying avoids unnecessary removal of tooth substance, while identifying the optimal path of insertion. In many dental offices, this most important phase of dental diagnosis is delegated to the dental laboratory because the dental surveyor is absent or because the dentist is apathetic³. This situation places the technician in the role of diagnostician, which is illegal and unethical. According to the Brazilian Code of Dentistry Ethics, diagnosis, prognosis, treatment planning and treatment are dentist's responsibilities²⁴. In the USA, the legislation states that the dentist has ultimate responsibility for all dental treatment, including the design and material of any prosthesis produced by dental laboratories. State laws require a written Work Authorization Order to accompany all work sent by a dentist to a dental laboratory⁴. The work authorization must be made in duplicate and both the dentist and dental laboratory technician must retain a copy for a specified period. Thus documents are available to substantiate or refute claims and counterclaims that concern the illegal practice of dentistry or to aid in the settlement of misunderstandings between a dentist and a dental laboratory technician³. The distinction between the clinician's and dental technician's responsibilities, as well as the risks posed by poor-quality denture designs to oral health, should be clearly understood for the ethical provision of RPDs with no harmful effects to patients.

In summary, this study demonstrated that the construction of cobalt-chromium RPDs by commercial private dental laboratories in the Northeastern region of Brazil presents the same issues already found in other countries⁶⁻¹². The majority of master casts examined was sent to dental

laboratories without any design information and did not comply with ethical guidelines in the provision of RPD. Mouth preparation frequently failed for guiding planes, retentive areas and rest seat distribution. These findings reinforce the fact that distinction between the clinician's and dental technician's responsibilities should be clearly understood. Available evidence suggests an association between dentist's knowledge and denture service quality. Therefore, it is necessary to provide students with adequate clinical experience in the dental school environment that will in turn carry into the practice of dentistry. The growing population and extended life expectancy, both associated with the reduction in tooth loss, may contribute to increase the prevalence of partially dentate adults and the need for RPD.

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